12th Internacional Conference and Exhibition On Emissions Monitoring

# Determination of methane and carbon dioxide surface emissions in a Spanish landfill

*C. Sánchez ;A. Narros ; I. del Peso ; M.M. de la Fuente ; E. Rodríguez

Department of Chemical and Environmental Engineering,
Technical University of Madrid

*carlos.sanchezf@upm.es

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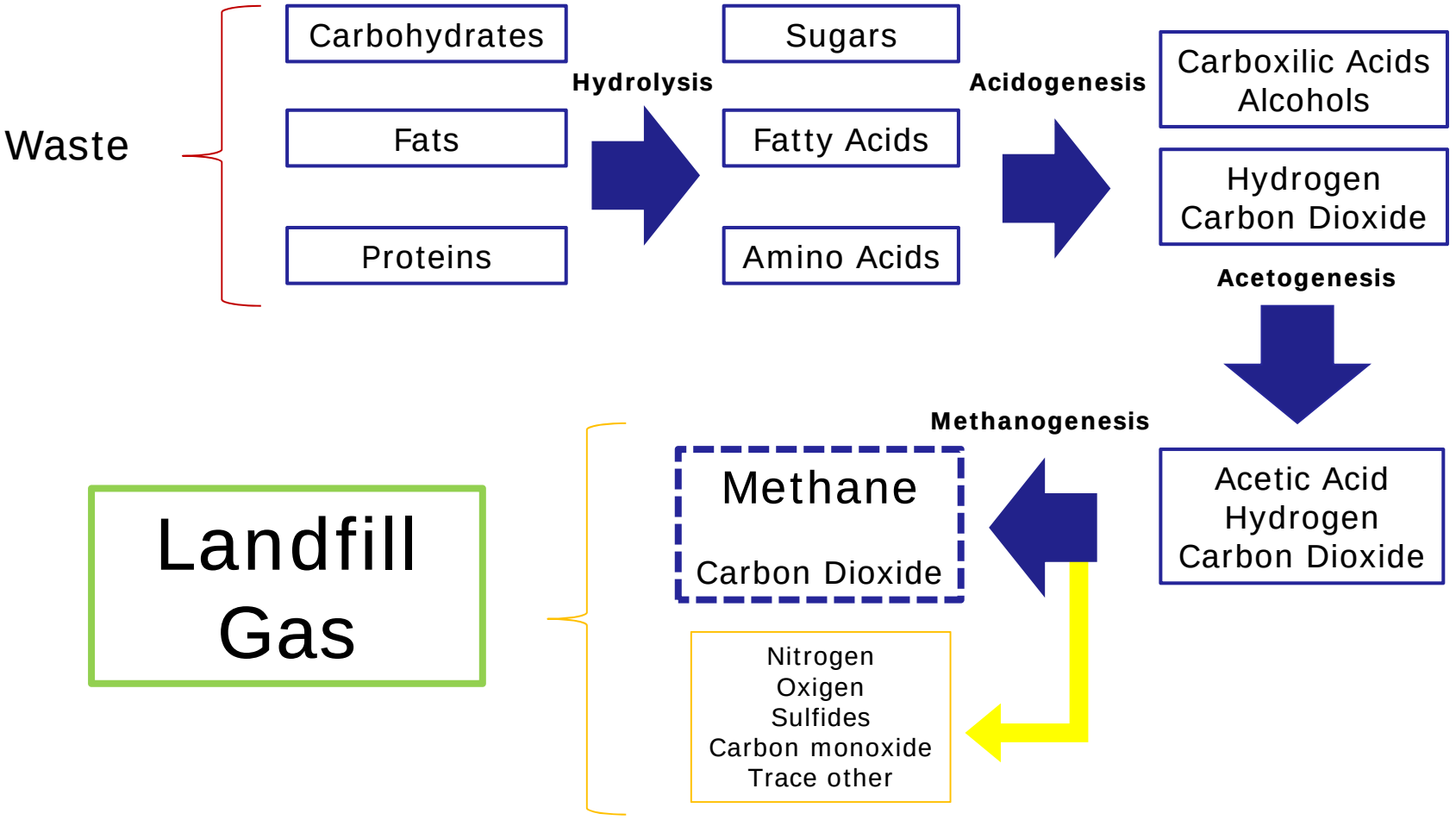
May, 19th 2016

# Objective

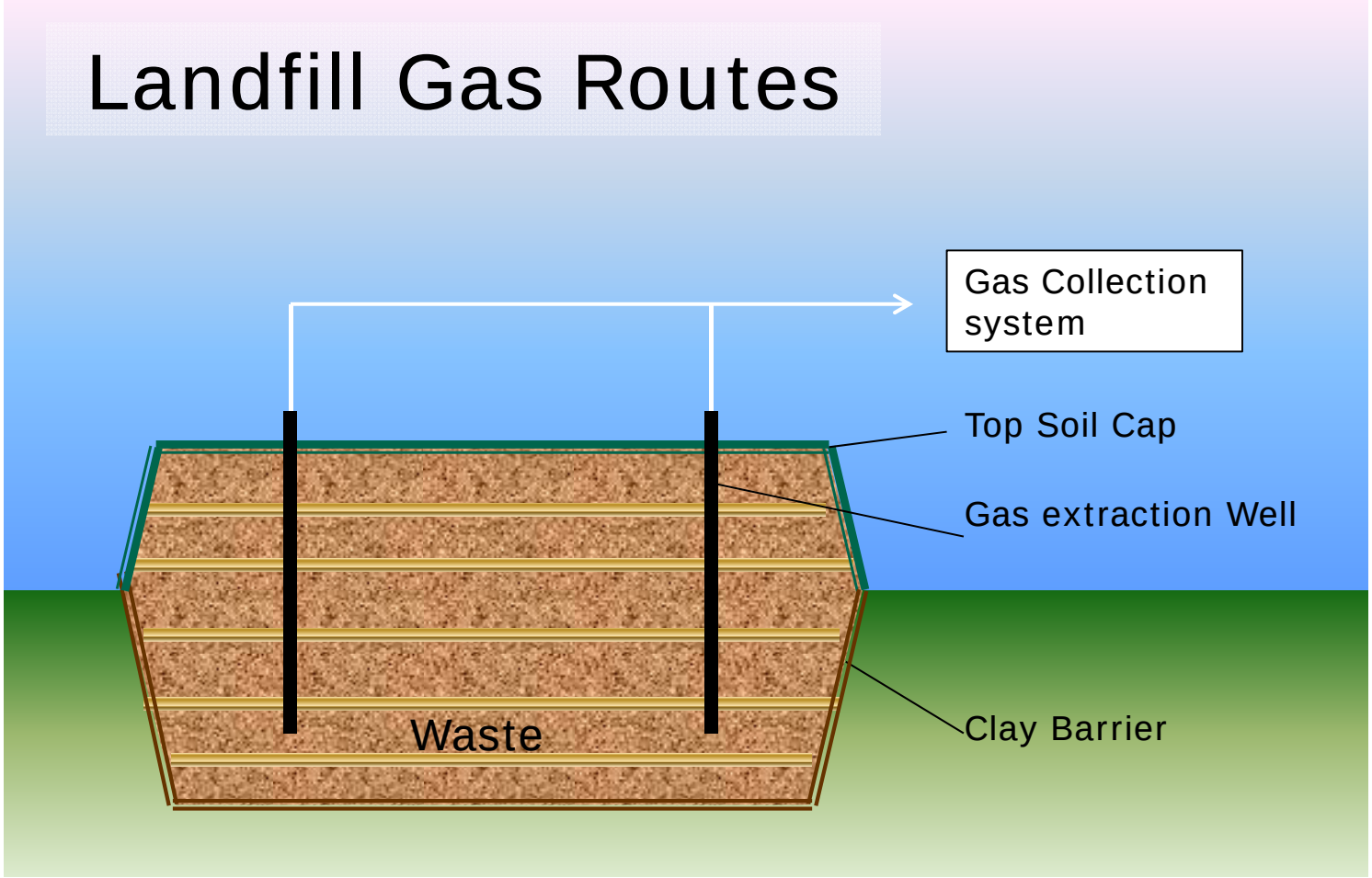
- Estimate the total surface emission of methane and carbon dioxide in two spanish landfills

- Compare this calculated data with those provide by a theoretical model (IPCC)

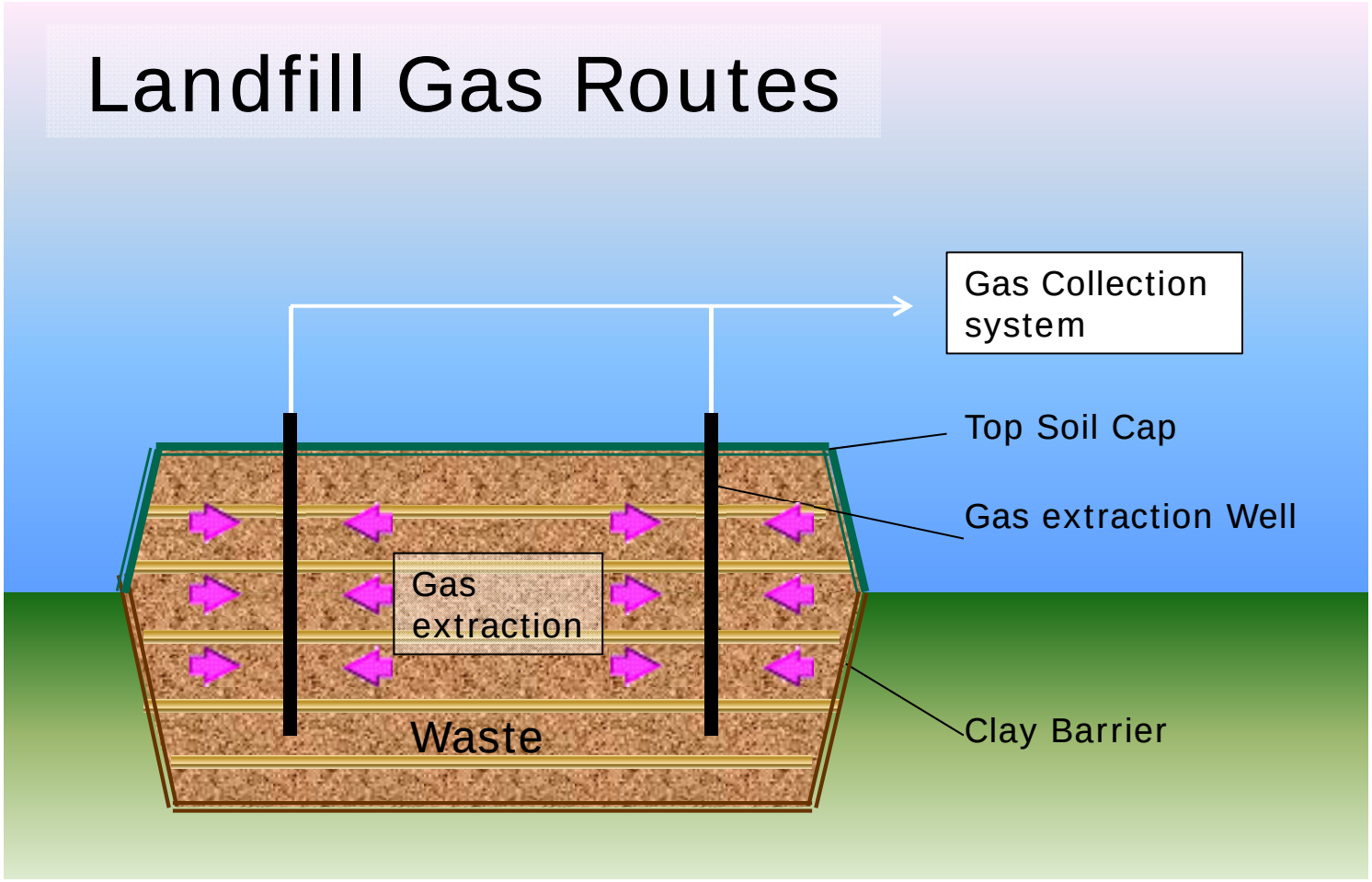
# *Introduction*


Waste
Carbohydrates
Fats
Proteins
Hydrolysis
Sugars
Fatty Acids
Amino Acids
Acidogenesis
Carboxilic Acids
Alcohols
Hydrogen
Carbon Dioxide
Acetogenesis
Acetic Acid
Hydrogen
Carbon Dioxide
Methanogenesis
Methane
Carbon Dioxide
Nitrogen
Oxigen
Sulfides
Carbon monoxide
Trace other
Landfill Gas

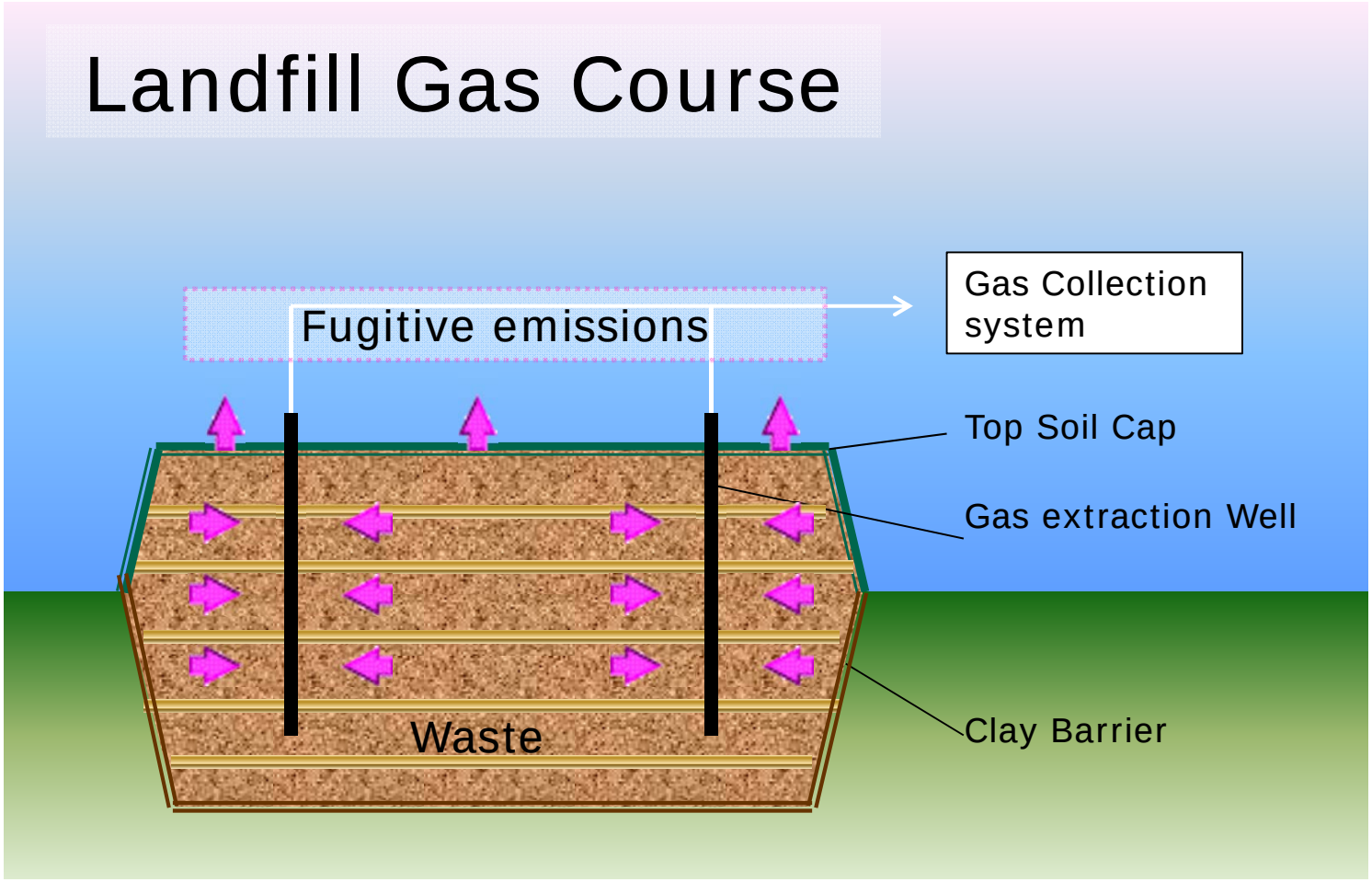
# Landfill Gas Routes



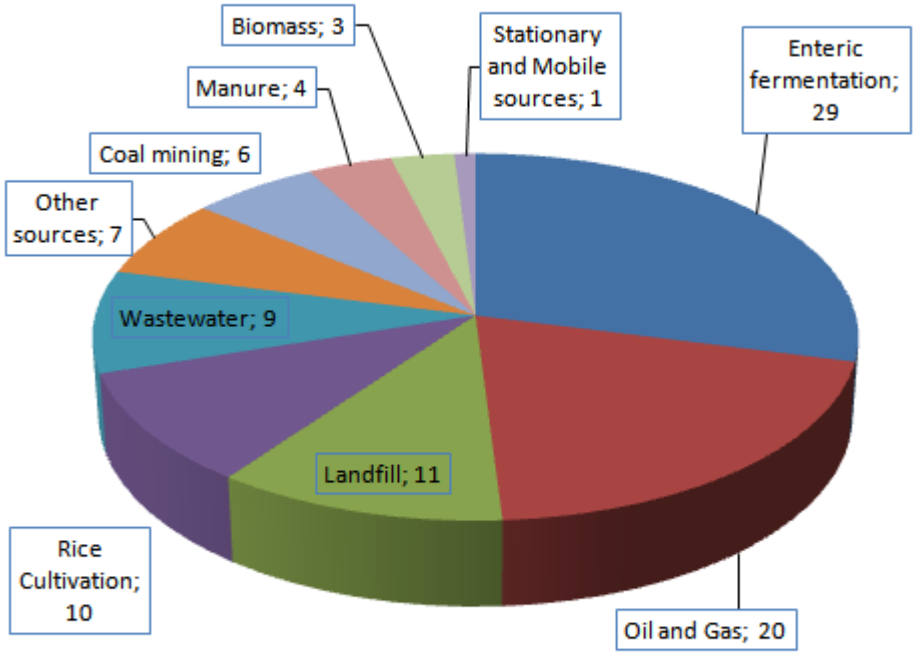
# Landfill Gas Routes



# Landfill Gas Course



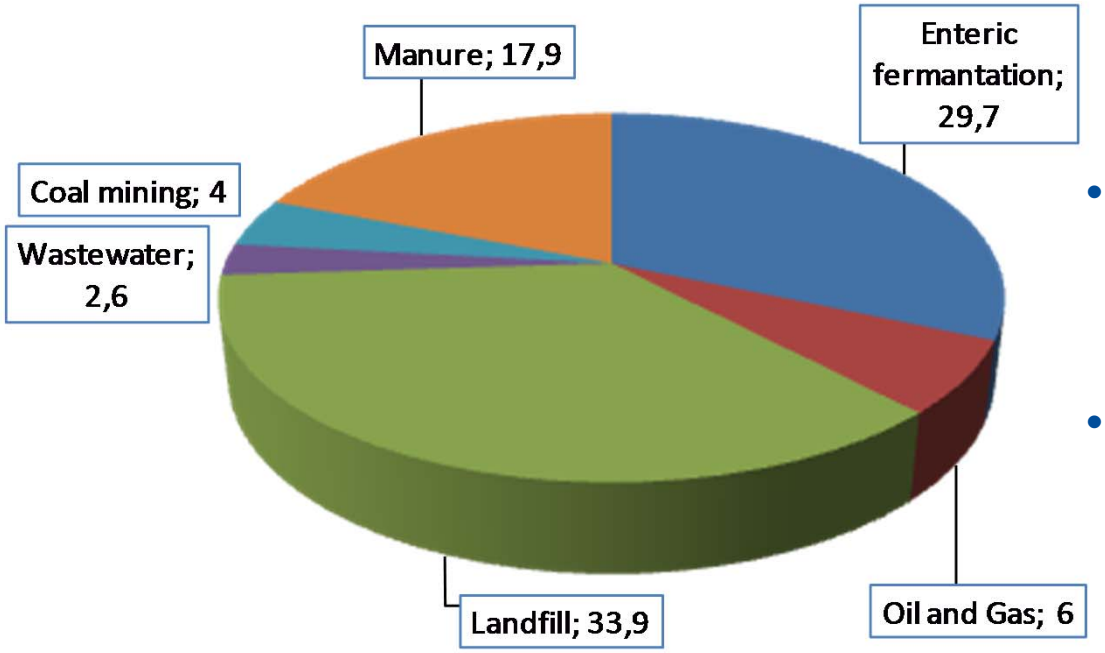
# World Anthropogenic Methane Emissions




- Landfill are responsible of 11% of methane global anthropogenic emissions
- It is the third largest source of anthropogenic methane in the world

***Source: EPA*** **(Global Anthropogenic Non-$CO_2$ Greenhouse Gas Emissions: 1990 – 2030)**

# Spanish Anthropogenic Methane Emissions




- In Spain, landfills release more than 33% of the total methane emitted
- It is the first source of anthropogenic methane in Spain

***Source: EINECS*** **(European In**ventory of **E**xisting **C**ommercial chemical **S**ubstances**)**

# *Site description*

The study was carried out in two landfills in the Community of Madrid very close between them:

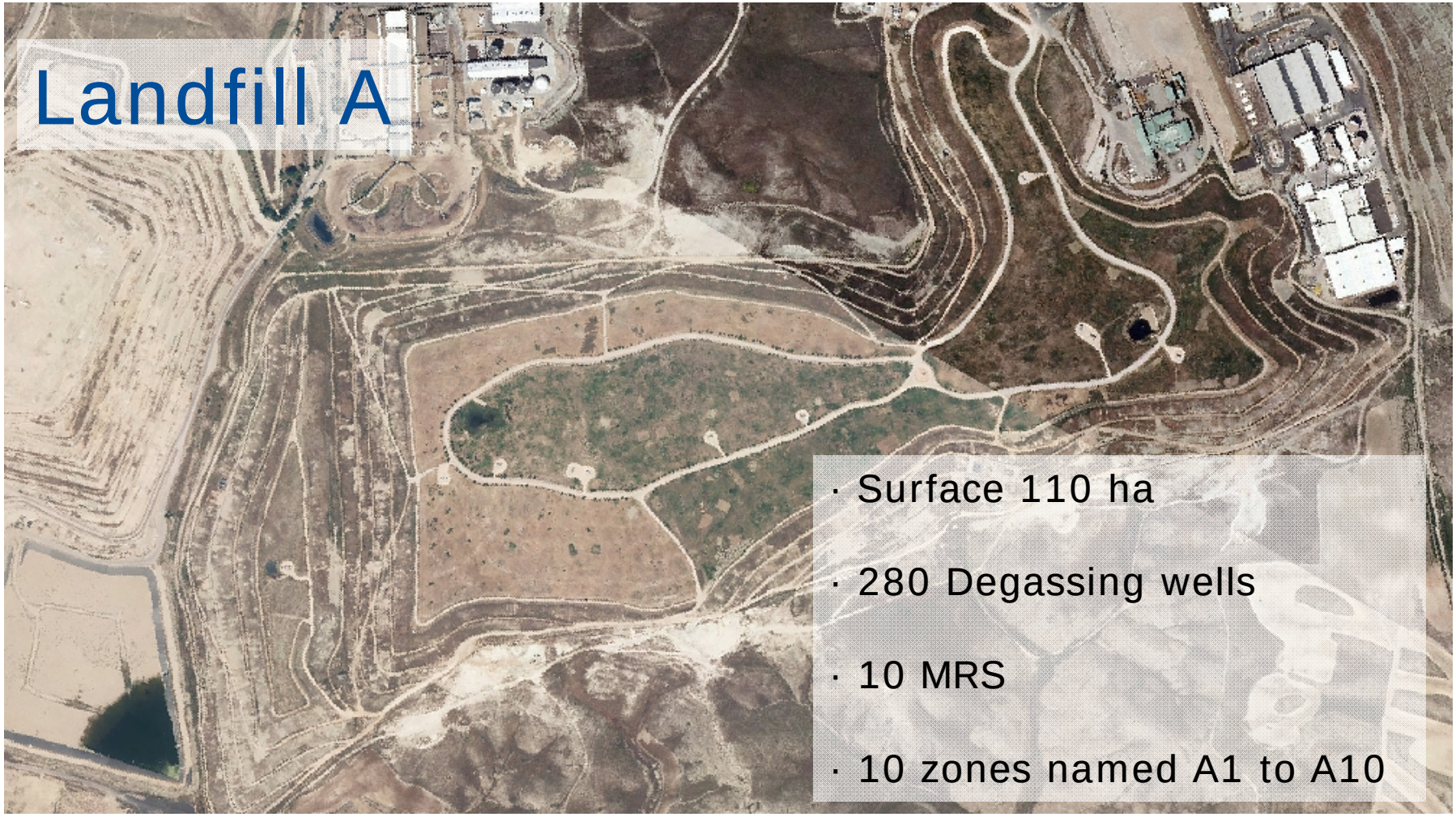
## Landfill A

- Status: Closed
- Age: 1978-2000
- Seal: with HDPE
- LFG: Valorized

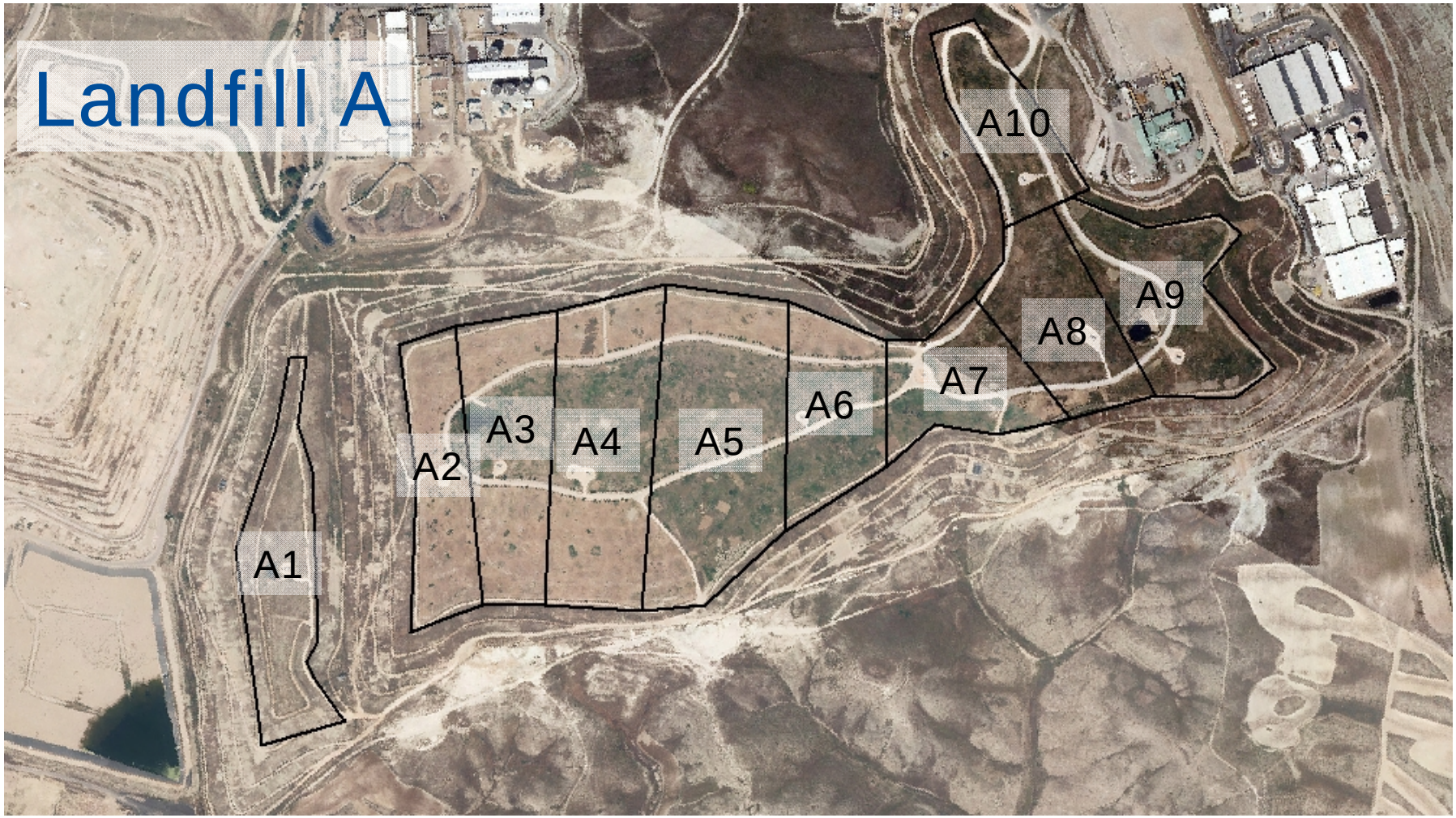
## Landfill B

- Status: Current use
- Age: 2000-2014
- Seal: without HDPE
- LFG: Burnt

# Landfill A



- Surface 110 ha
- 280 Degassing wells
- 10 MRS
- 10 zones named A1 to A10


Landfill A
A10
A9
A8
A7
A6
A5
A4
A3
A2
A1

# Landfill B

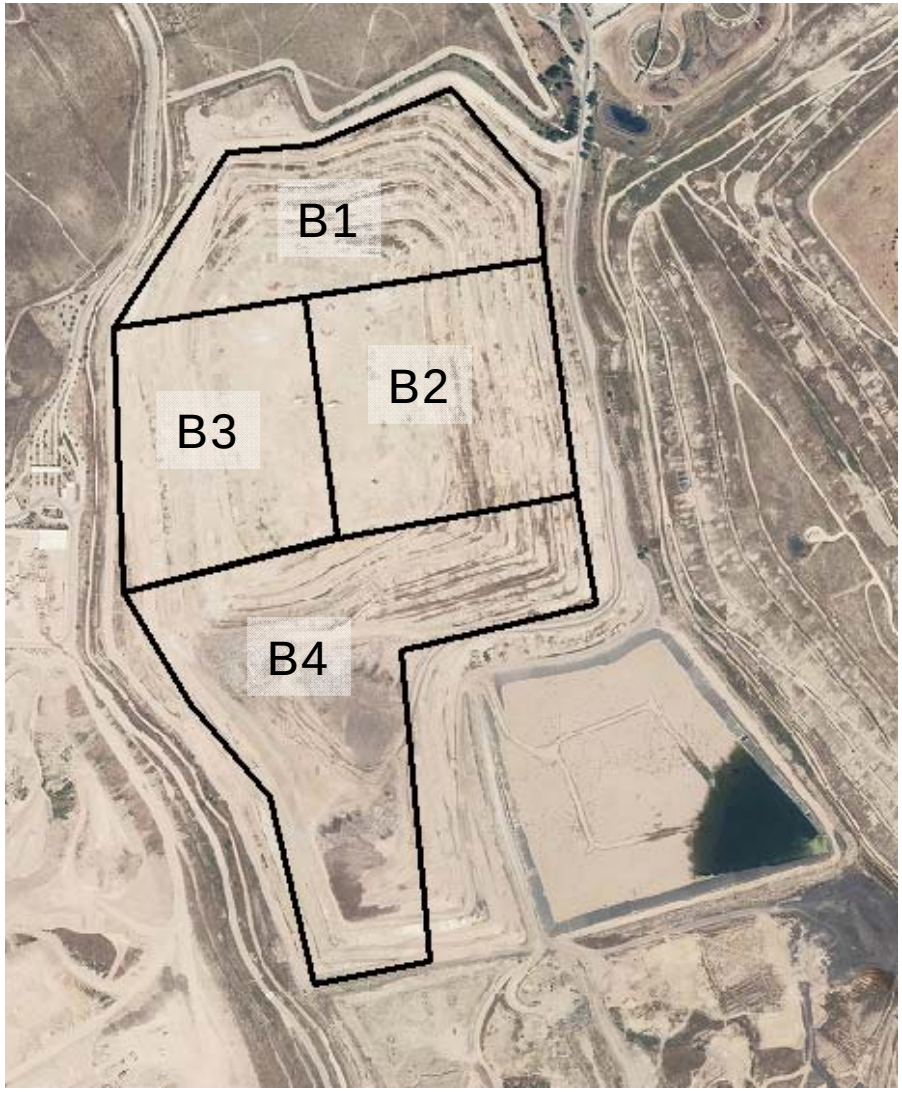
· Surface: 80 ha

· 4 cells filled and sealed

# Landfill B

· Surface: 80 ha

· 4 cells filled and sealed

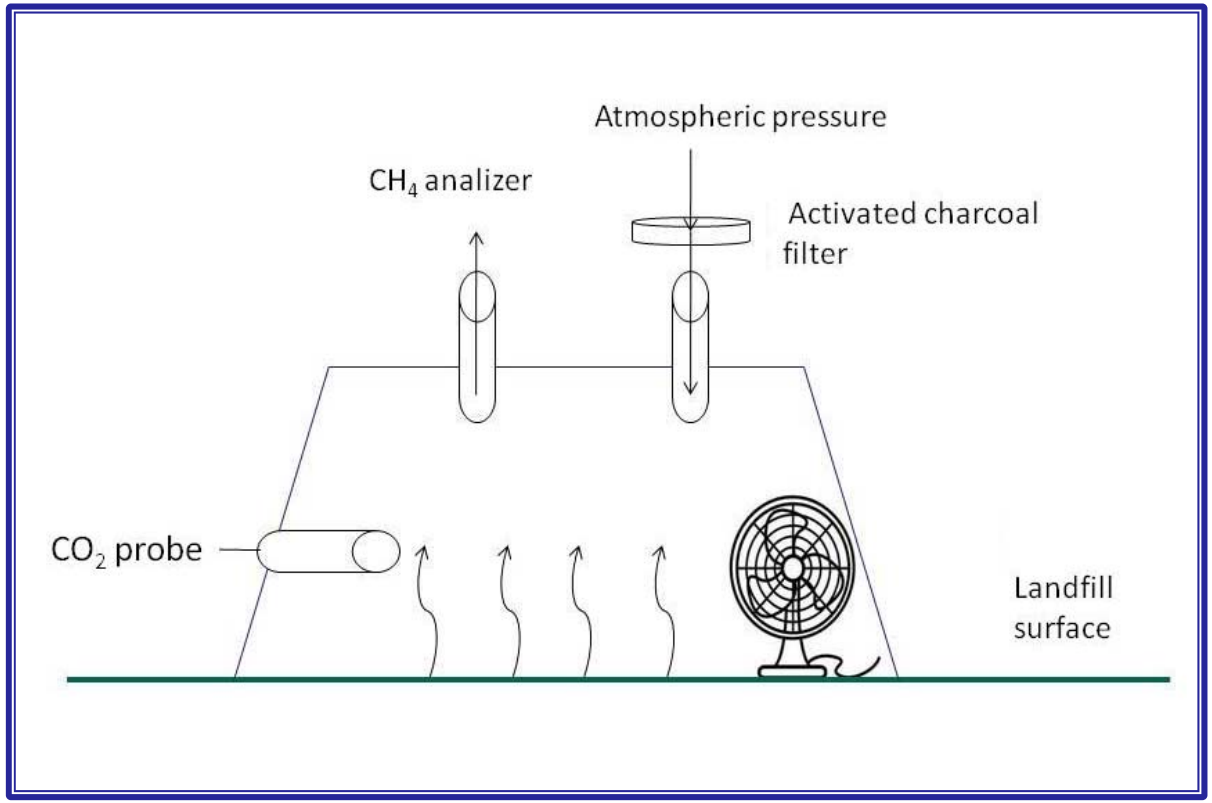


# Methodology

# *Walkover survey*

- Consists on a sweep walk on the landfill sampling the air at ground level
- The methane concentration gives information about the main sources of emission
- The amount and distribution of these sources of emission is used as qualitative data to decide the sampling points for the flux box campaigns

# *Flux box scheme*




## Main Characteristics

- **Known volume**
- **Known foot print surface**
- **Allows to get a good seal against the surface**

Very cheap and commercially available materials have been used to make these flow chambers

## $CO_2$ analyzer (KIMO HQ210)

- Works through a passive probe that is placed inside de flux box
- Range of concentrations of $CO_2$ between 0 and 5000 ppm
- Temperature and relative humidity is also measured

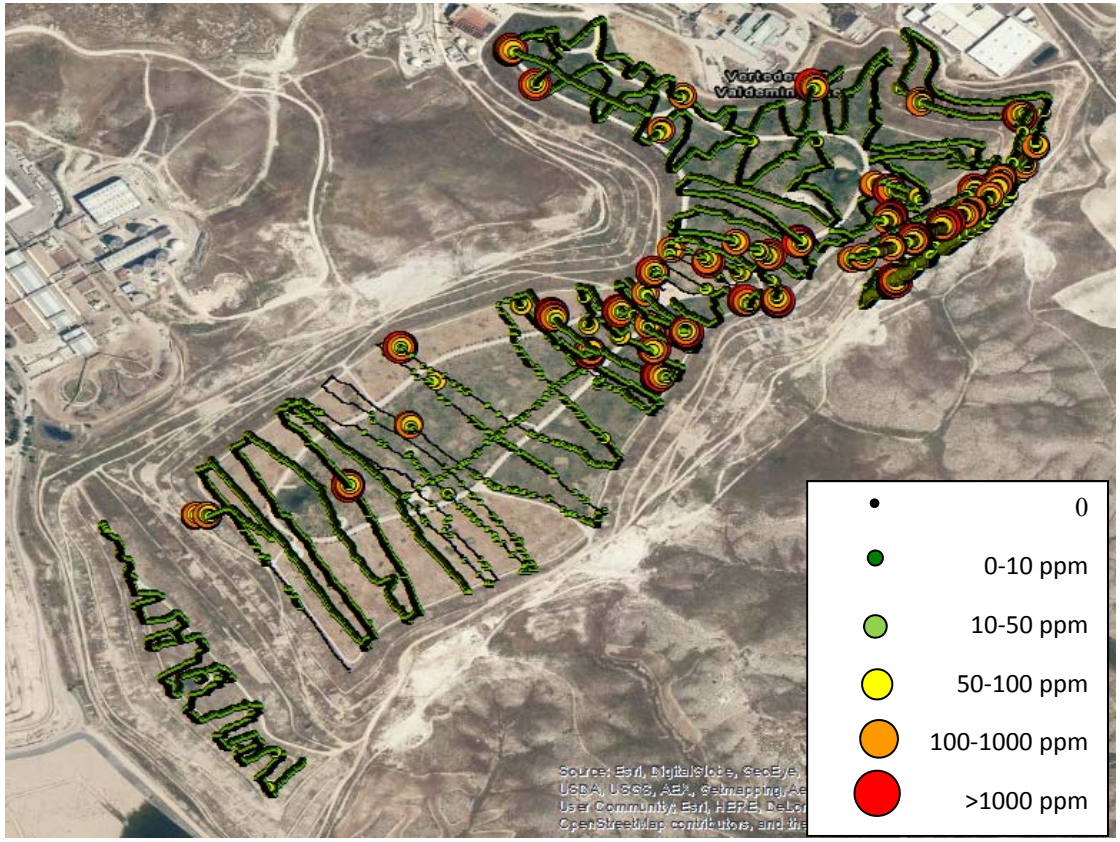
# $CH_4$ Analyzer (Sensit PMD)

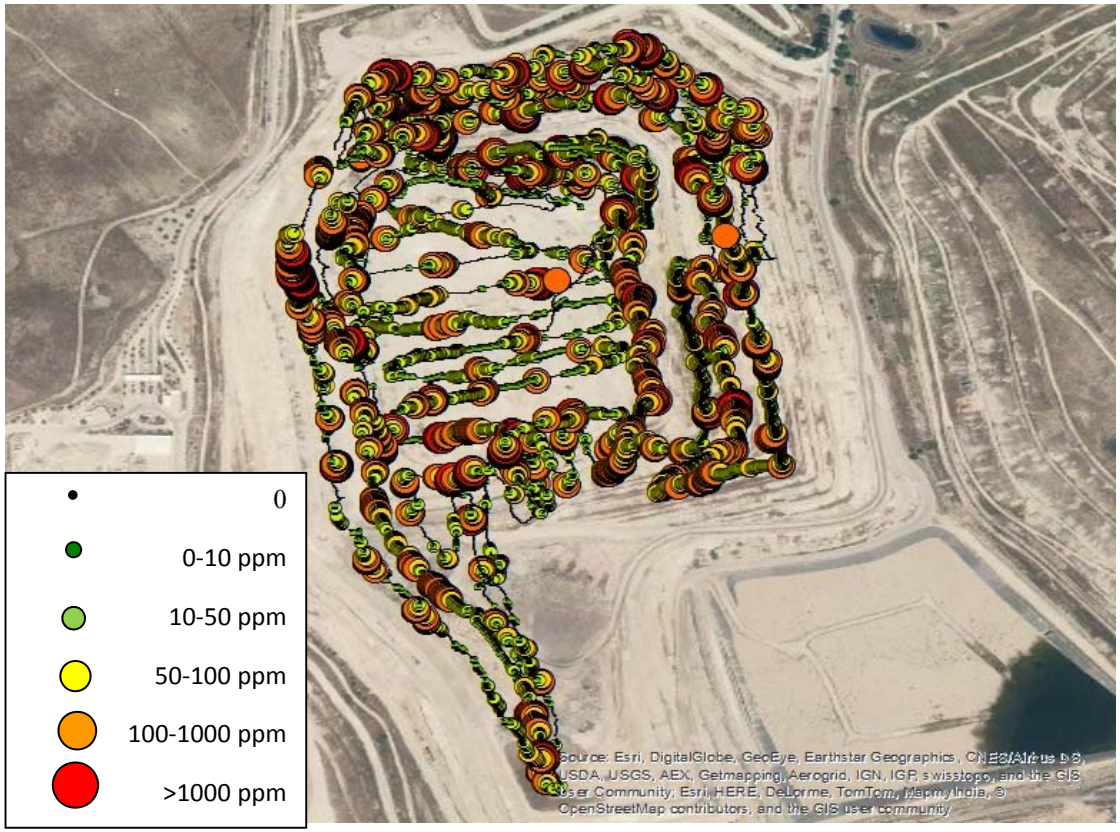
- Portable Methane Detector with Infrared (IR) Absorption Spectroscopy sensor
- Designed to detect methane gas from 1ppm up to 100% volume
- An internal pump provides rapid sampling into the detection chamber
- Provided of GPS and Data Logging

# *Results*

# Walkover survey results (Landfill A)

- The distribution of the main emission sources is not homogeneous in the top zone
- The quantity and proximity of points with high methane concentration is higher in the side and slopes zones than in the top






# Walkover survey results (Landfilll B)

- The distribution of the main emission sources can be considered homogeneous
- The quantity and proximity of points with high methane concentration is not much higher in the side and slope zones than in the top

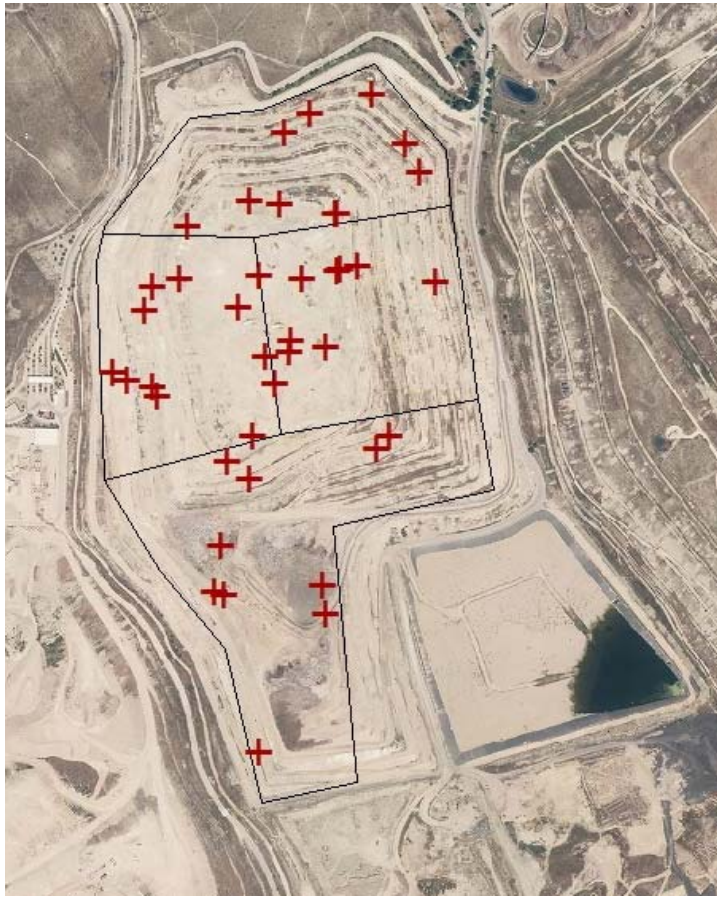
**Results of the walkover survey are use as information to choose the sample points for the flux box campaign**

# Landfill A

**The number of sample points in each of the ten zones is determined acording to the number of high methane concentrations points found in the walkover survey**

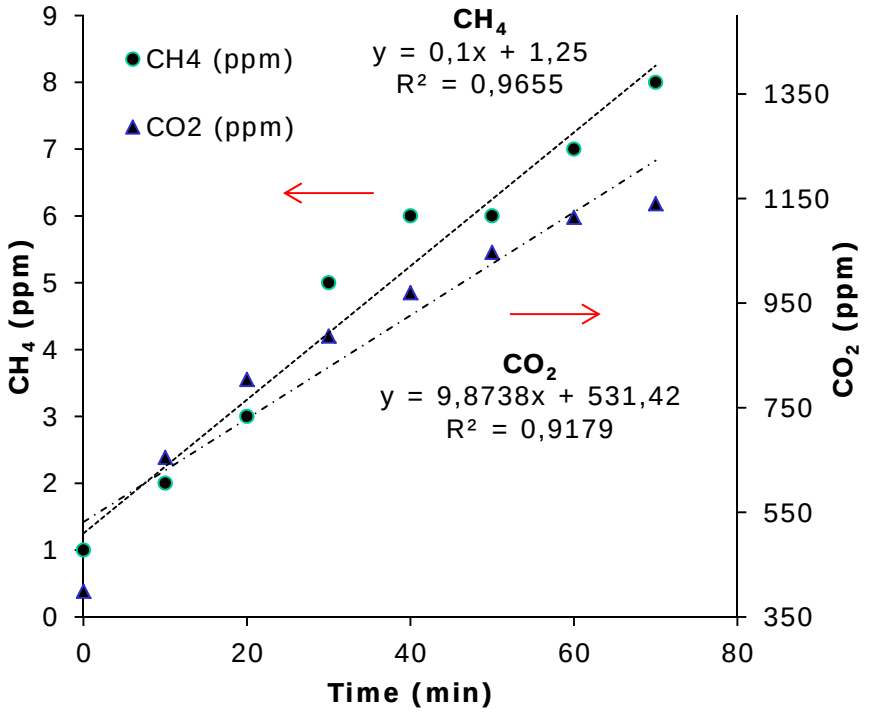
# Landfill B

**The walkover survey results show an homogeneous distribution of the main methane sources. A stratified sampling has been proposed to cover this part of the study.**

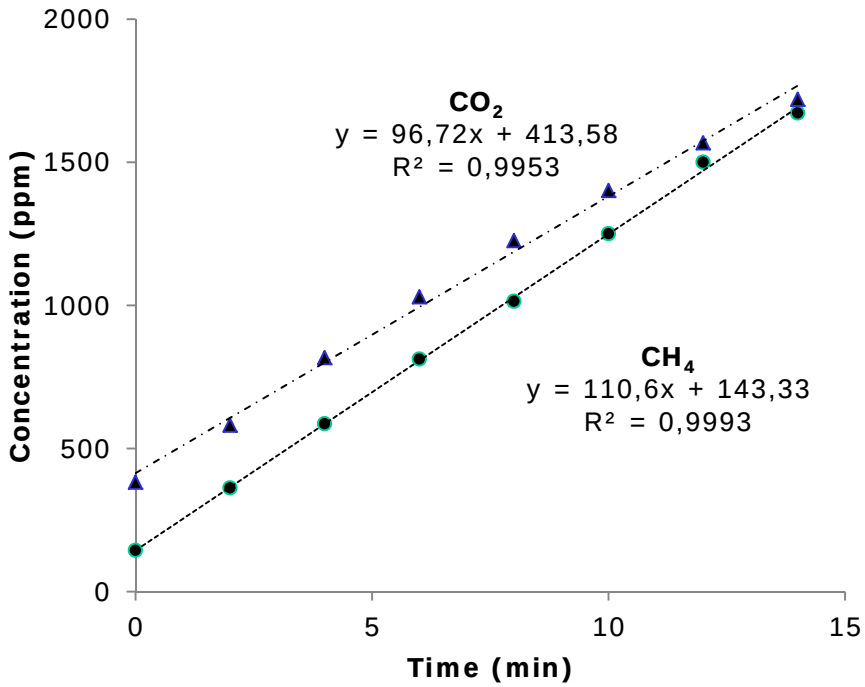


# Flux Box Results

## Figure 1




## Figure 2




Examples of data collected with a flux box in a point with low **(figure 1)** and high **(figure 2)** emission of methane and carbon dioxide

## Results of calculated total methane and carbon dioxide emission for each zone

*Landfill A*

| Zone | $CH_4$ Emission (mg/h·m²) | $CO_2$ Emission (mg/h·m²) | Surface (m²) | Total emission $CH_4$ (g/h) | Total emission $CO_2$ (g/h) |
|---|---|---|---|---|---|
| A1 | 0,2432 | 29,53 | 4,56E+04 | 11,10 | 1,35E+03 |
| A2 | 0,1074 | 36,99 | 3,61E+04 | 3,88 | 1,34E+03 |
| A3 | 0,2894 | 121,8 | 5,10E+04 | 14,75 | 6,21E+03 |
| A4 | 0,3227 | 44,39 | 6,83E+04 | 22,04 | 3,03E+03 |
| A5 | 0,2470 | 49,35 | 8,26E+04 | 20,41 | 4,08E+03 |
| A6 | 0,1423 | 64,15 | 3,80E+04 | 5,41 | 2,44E+03 |
| A7 | 0,3662 | 135,8 | 3,4E+04 | 12,95 | 4,80E+03 |
| A8 | 27,7454 | 100,7 | 4,13E+04 | 1145,09 | 4,16E+03 |
| A9 | 0,1980 | 141,7 | 5,03E+04 | 9,94 | 7,12E+03 |
| A10 | 0,7445 | 404,6 | 3,18E+04 | 23,67 | 1,29E+04 |
| Slopes | 943,54 | 2874 | 4,00E+05 | 1,91E+05 | 3,77E+05 |
| ∑ | | | | **1,92E+05** | **4,25E+05** |

**Annual total emission (Ton/year):** **$CH_4$ 1681,92** **$CO_2$ 3723**

## Results of calculated total methane and carbon dioxide emission for each zone

*Landfill B*

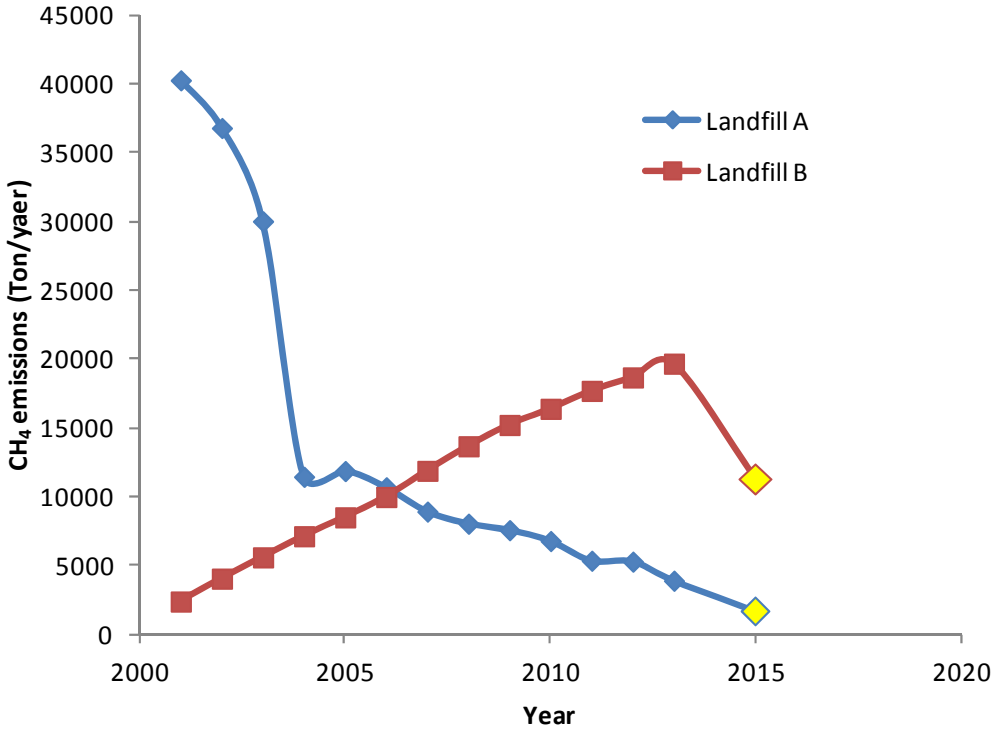
| Zone | $CH_4$ Emission ($mg/h \cdot m^2$) | $CO_2$ Emission ($mg/h \cdot m^2$) | Surface ($m^2$) | Total emission $CH_4$ (g/h) | Total emission $CO_2$ (g/h) |
|---|---|---|---|---|---|
| B1 | 7,17E+03 | 2,36E+03 | 6,84E+04 | 4,91E+05 | 1,61E+05 |
| B2 | 1,23E+03 | 9,04E+02 | 6,22E+04 | 7,68E+04 | 5,63E+04 |
| B3 | 8,80E+03 | 2,57E+03 | 7,00E+04 | 6,16E+05 | 1,80E+05 |
| B4 | 8,60E+02 | 3,08E+03 | 1,19E+05 | 1,02E+05 | 3,67E+05 |
| Σ | | | | 1,29E+06 | 7,64E+05 |

**Annual total emission (Ton/year):** **$CH_4$ 11.300,40** **$CO_2$ 6.692**

# *Conclusions*

- Measured data of landfill emissions are of the same order of magnitude than the estimated data in the inventory of the municipality of Madrid
- The calculated data for the landfill A follow the decreasing trend of recent years
- There are significant differences in the values obtained for landfill B. In this case the model gives an emission value which is twice the measured emission

Annual total emission of methane




***Source:*** Air Pollutant Emissions Inventory of the municipality of Madrid (2013). Madrid City Council

# Thank you for your attention

Carlos Sánchez Fernández

Department of Chemical and Environmental Engineering,
Technical University of Madrid

carlos.sanchezf@upm.es

## *Acknowledgements*

This study was developed in the scope of the project “Optimización de la gestión de residuos municipales” (CTQ 2013-48280-C3-2R) funded by the Spanish Ministry of Economy and Competitiveness.